Algorithm for Modeling Unconventional Machine Tool Machining Parameters using Artificial Neural Network

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Abstract- **Unconventional machining process finds a lot of application in aerospace and precision industries. It is preferred over other conventional methods because of the advent of composite and high strength to weight ratio materials, complex parts and also because of its high accuracy and precision. Usually in unconventional machine tools, trial and error method is used to fix the values of process parameters. In the proposed work an algorithm which is developed using Artificial Neural Network (ANN) is proposed to create mathematical model functionally relating process parameters and operating parameters of any unconventional machine tool. This is accomplished by training a feed forward network with back propagation learning algorithm. The required data which are used for training and testing the ANN in the case study is obtained by conducting trial runs in EBW machine. By adopting the proposed algorithm there will be a reduction in production time and set-up time along with reduction in manufacturing cost in unconventional machining processes. This in general increases the overall productivity. The programs for training and testing the neural network are developed, using MATLAB package**

Keywords: **Algorithm, Unconventional machining processes, mathematical modeling, Artificial Neural Network.**

I. INTRODUCTION

Unconventional machining process is very widely used today because of the problems posed by new high strength alloys and high strength to weight ratio composite materials to the conventional machining processes. They find wide application in nuclear, aerospace and automobile industries. The main advantages of unconventional process are is its capability to produce intricate shapes, independent of work piece material properties, contact less machining etc,. An artificial neural network (ANN) [3] refers to computing systems whose central theme is borrowed from the analogy of biological neural networks. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network. These networks are similar to the biological neural networks in the sense that functions are performed collectively and in parallel by the units, rather than there being a clear delineation of subtasks to which various units are assigned.

A. Literature Survey

Previous research work undergone in unconventional machining includes the statistical analysis of the electron beam welding of stainless steel samples by Elena Koleva in 2001. It was done using multi response statistical techniques. A model is created which includes the values of the distance between the electron gun and both the focusing plane of the beam and the sample surface as parameters. The response at work surfaces for the welding depth and width for variable beam power, welding speed, and the above two distances, determining the position of the beam focus towards the sample surface can be found. These predicted results coincide with the existing experimental experience in this technique, after that computer procedures for the choice of operating conditions under some special criteria is made for obtaining some special parameters in the seam [2]. In the work done by Barreda and Santamaría in 2001, compositional changes of the welds carried out by the electron beam welding process have been investigated. Addition of filler metal in the weld fusion zone has been used to solve some problems by improving the behavior of the joint by minimizing the porosity, the notching or the cracking susceptibility of the joint. The main purpose of this work is to investigate the behavior of a 17 mm Ti6Al4V weld by the electron beam welding process with a filler metal of similar and dissimilar composition to the base plate [5]. Fragomeni and Nunes, Jr. (2003) have presented a study on the effects of welding parameters on electron beam welding in the space environment. It was undertaken in order to be sure that no hazard would exist from impingement of hot molten metal particle detachments upon an astronauts' space suit during any future electron beam welding exercises or experiments. This investigation was undertaken to evaluate if molten metal could detach and come in contact with astronauts and burn through the fabric of the astronauts. Extravehicular Mobility Unit during electron beam welding in space. Molten metal detachments from either the weld/cut substrate or weld wire could present harm to an astronaut if the detachment was to burn through the fabric of the astronaut's space suit. Theoretical models were developed to predict the possibility and size of the molten metal detachment hazards during the electron beam welding exercises at Low Earth Orbit. Some possible ways of obtaining molten metal drop detachments would include an impulse force, or bump, to the weld sample, cut surface, or filler wire [4].

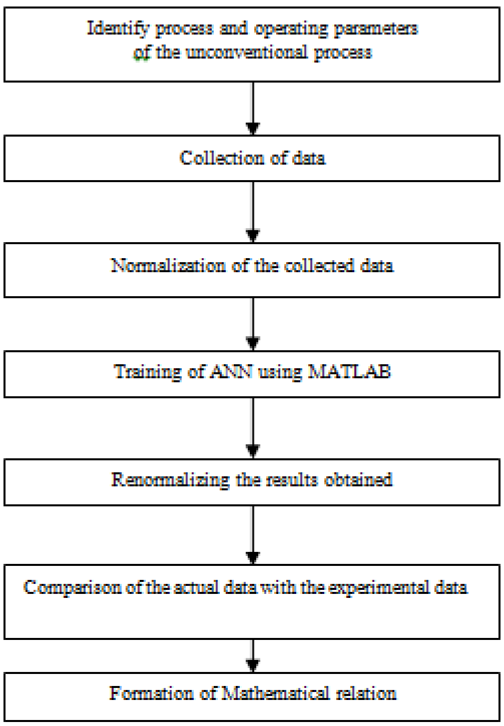
II. PROBLEM DESCRIPTION

In the industries, usually the values of unconventional machining process parameters are finalized by trial and error method. It may be suitable for non-fabrication industries. But it is not convenient in the field of aerospace industry,

DOI: 01.IJMMS.01.01.535

where the expectation for quality and reliability is high. It will take much time to conduct the trials on high cost material, which leads to loss in profit also. In this context, it is proposed to form an algorithm for formulating functional relationship between the process parameters and operating parameters of any unconventional machining process for easily finding out the optimum value of parameters required for good machining quality.

III. METHODOLOGY



IV. CASE STUDY

A case study has been conducted on the electron beam welding process which was conducted on an Aluminium alloy having thickness varying from 3-24 mm. The process parameters such as accelerating voltage, beam current, welding speed, focus current, gun-to-work distance corresponding to various operating parameters such as bead width and depth of thickness were collected. The process parameters and operating parameters were normalized. The range of normalization is between 0.1-0.9. The artificial neural network was trained by using normalized parameters. The training process have been done using MATLAB package. The effect training a feed forward network with back propagation learning technique was used. As a result of training experimental values were obtained and those values are renormalized. After renormalization the result is validated by comparing the actual data with the experimental data. Finally the relation between the process parameters and operating parameters are formulated. Here with this proposed formula optimum process parameters can be calculated.

A. Collection of data

The data used for this project were collected from an industry in south India. Here the parameters are selected accelerating voltage, beam current, welding speed, focus current, gun-to-work distance and bead width, depth of penetration as operating parameters

B. Normalization of the collected data

The data which have been collected were normalized using the formula shown below:

$$P' = [(0.8/(P_{max} - P_{min})) * (P - P_{min})] + 0.1$$

Where

P'- normalized value

P_{max}- maximum value in the corresponding set of parameter

P_{min}-minimum value in the corresponding set of parameter

C. Training of ANN using MATLAB

The artificial neural network is trained using the normalized values. A training program is used for this purpose. After training this program, the results were obtained by using a test program. The weight and bias values obtained as a result of training.

D. Renormalizing the results

The results obtained after testing were renormalized with the help of the formula given below.

$$P = [\{(P' - 0.1) * (P_{max} - P_{min})\}/0.8] + P_{min}$$

Where

P'- normalized value

P_{max}- maximum value in the corresponding set of parameter.

P_{min}-minimum value in the corresponding set of parameter.

E. Comparison of the actual data with the experimental data

After renormalizing the values have been compared with the experimental data obtained through training with the actual values obtained from an industry in south India.

F. Formation of mathematical relation

By using the weight and bias values derived from the program a mathematical relation has been formulated between the process parameters and operating parameters.

V. CONCLUSION

In unconventional machining process trial and error method is used for finding the optimum process parameter values. Using proposed algorithm mathematical modeling of process parameters and operating parameters can be made. From the obtained model optimum process parameters can be calculated. A case study is also presented. Thus it is concluded that the optimal process parameters can be found out by using mathematical model arrived using the proposed

DOI: 01.IJMMS.01.01.535

algorithm. It paves way for reduction in production time and set-up time, along with the reduction in cost in any unconventional machining processes. It will increase the productivity. It also paves way for automation.

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DOI: 01.IJMMS.01.01.535